Final Report
on
Hazards Monitoring
At NASA Merritt Island Launch Area

VOLUME III

Task C -- Data Display and Transmission System

Contract No. NAS10-2009

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LIST OF ILLUSTRATIONS

1. INTRODUCTION

1.1 General

This report on Data Display and Transmission for the firing rooms of Launch Complex 37 is submitted in response to Task C, subtasks 1, 2, and 3 of Contract No. NAS10-2009, as amended, between NASA-KSC and Melpar, Inc.

The remaining three tasks under this contract are covered in the following three separately bound final reports:

Volume I, Task A -- Sensor Selection and Location for Apollo Fuel Transfer and Tanking System

Volume II, Task B -- Ultrasonic Leak Detectors for Cryogenics and Gases

Volume IV, Task D -- Measurements of Incident and Reflected UV and IR Electromagnetic Background at Saturn Complex 37.

1.2 Background

Under a previous contract[1] with the Safety Office, KSC, Melpar, Inc., developed a concept for a comprehensive display system for hazards associated with LC-39 and the Merritt Island Industrial Area. The display system included a master display located within the LCC, and subsidiary displays in both firing rooms and in the industrial area firehouse.

As the proposed hazards monitoring system for LC-39 progressed from concept through coordination and project approval, certain modifications to the original working hypotheses became evident. Perhaps foremost among the changes was the transfer of responsibility for the master display and the firehouse display from the Safety Office to other operating and/or support

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1. Volume II, Design Specifications, System for Detecting, Monitoring, Displaying, and Recording Hazardous Operation Information, NASA Contract No. NAS 10-1420, September, 1964.

groups. As a result, the Safety Office is now primarily concerned only with the summary consoles located in the two firing rooms. These are designated as the Operations Safety Consoles (OSC) and will be manned during checkout and launch by personnel of the Operations Safety Branch. Although no further direct design responsibility for the former consoles resides with the Safety Office, in Melpar's judgment the portions of the display system presented in reference 1 for which sensors and instrumentation will be provided still represent a valid and efficient means for indicating the status of potential hazards.

2. DATA DISPLAY -- OPERATIONS SAFETY CONSOLE (OSC)

From discussions with cognizant personnel at KSC, it was determined that the primary functional responsibility of the Operations Safety Office is that of assuring the safety of personnel who will be working on the pad during preparation for launch. Therefore, the ability to communicate quickly, directly, and unequivocally with a number of reporting stations assumes major importance. Provision for performing this function in a very flexible manner is provided on the right-hand console of the three provided the Safety Officer (figures 1 and 4). In addition to receiving information on the status of personnel, there exists a need for the safety officer to be informed, at least on a summary basis, immediately and automatically of the presence or absence of emergency conditions existing within the ground support equipment and/or the spacecraft. These data are presented in summary form on the left, or status console (figure 2). The center console, labeled Display (figure 3), provides four television monitors with which the Safety Officer can be apprised of situations under surveillance by the Operational TV (OTV) system, IR and UV TV, and the Meteorological Information Display System (MIDS).

2.1 Excluded Elements of the OSC

Certain end instruments, display elements, and control functions that have customarily been provided in the ensemble included on the OSC have now been intentionally eliminated. There are several reasons for this, namely, reassignment of prime responsibility for the function to another group; consideration of the logistics of installing and maintaining calibration of an instrument that is essential to and closely monitored by another organization or individual (such as the SRO); and re-evaluation of the real need of the

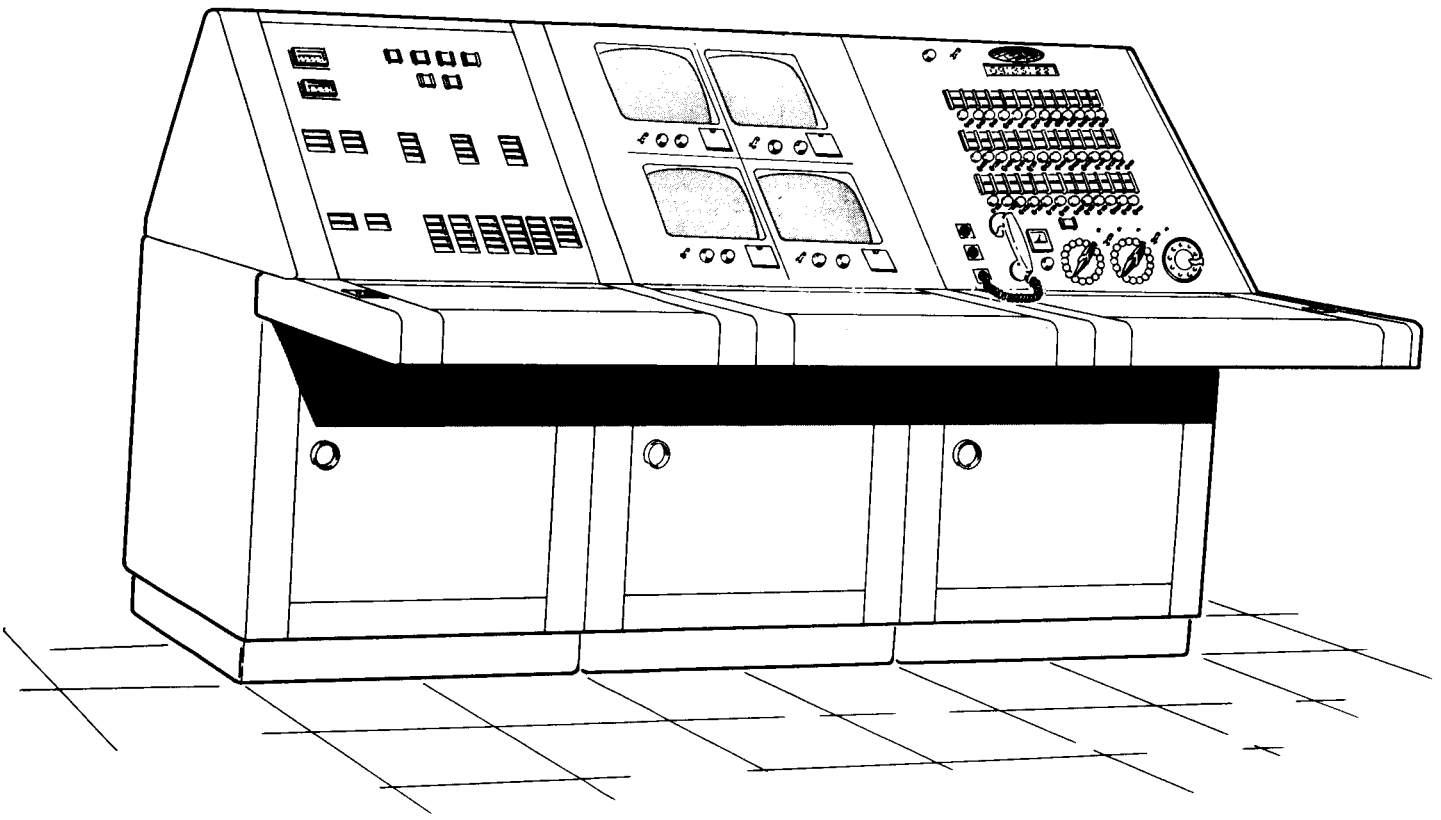

Figure 1. Operations Safety Console

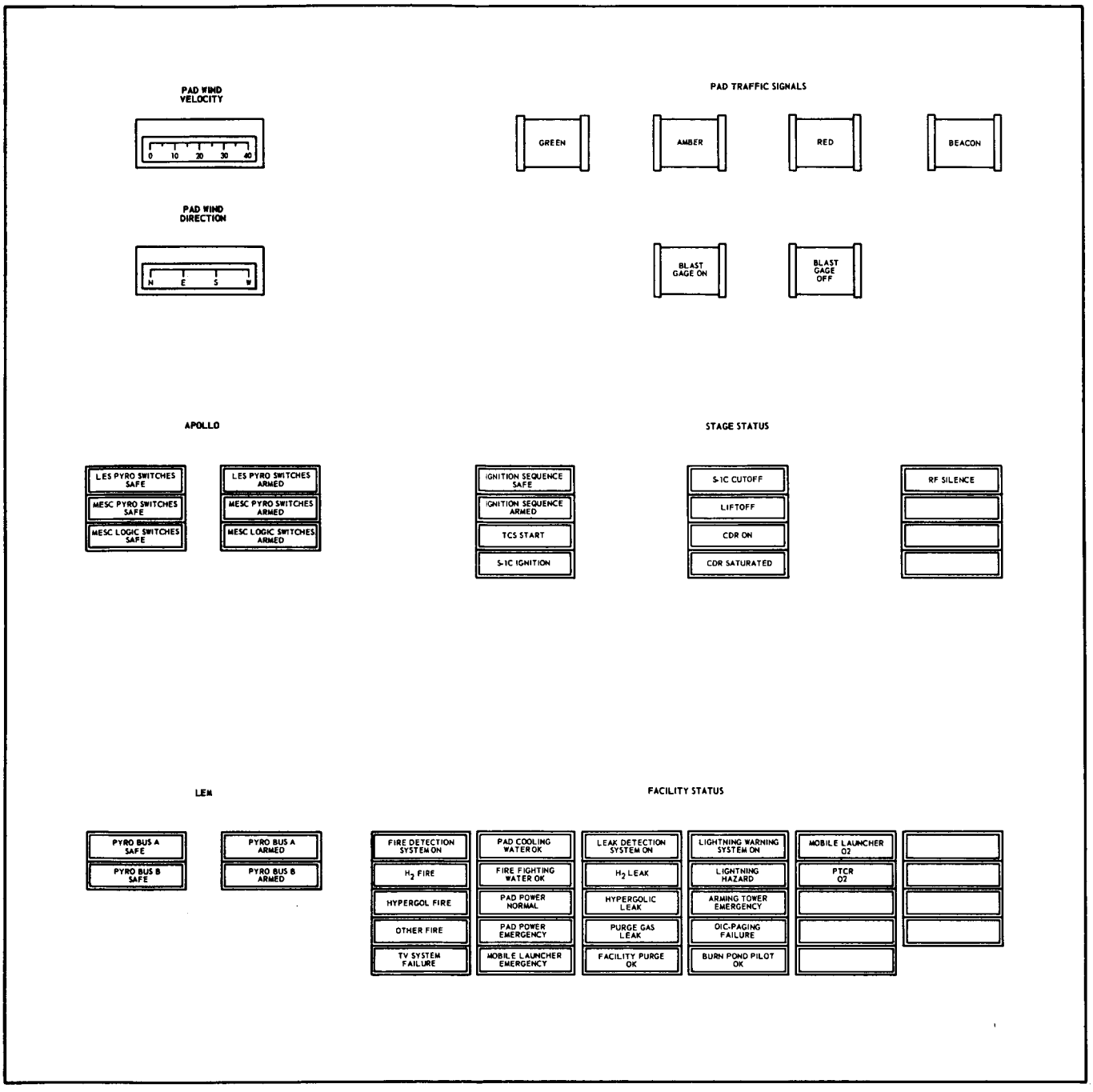

Figure 2. Status Console

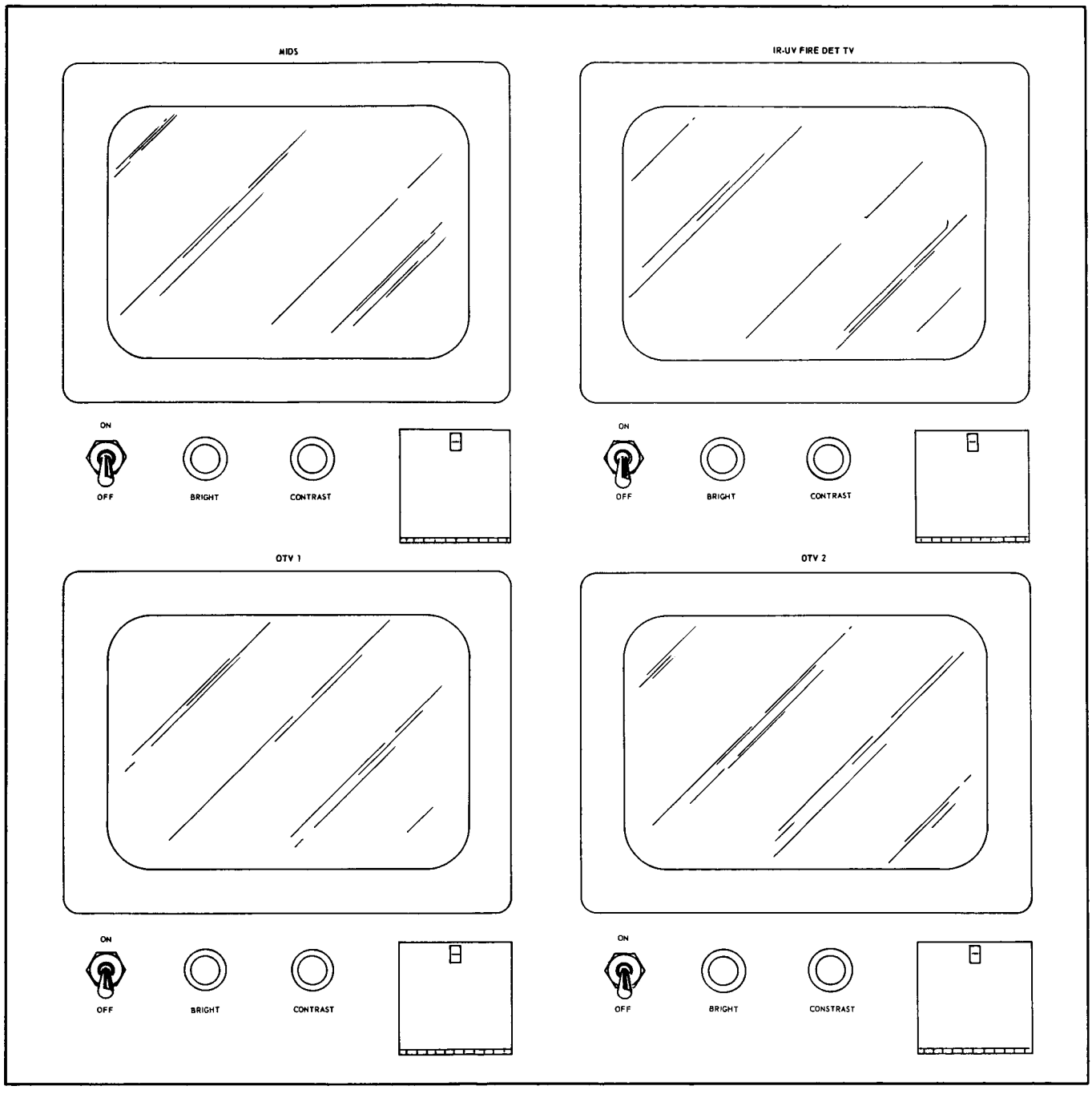

Figure 3. Display Console

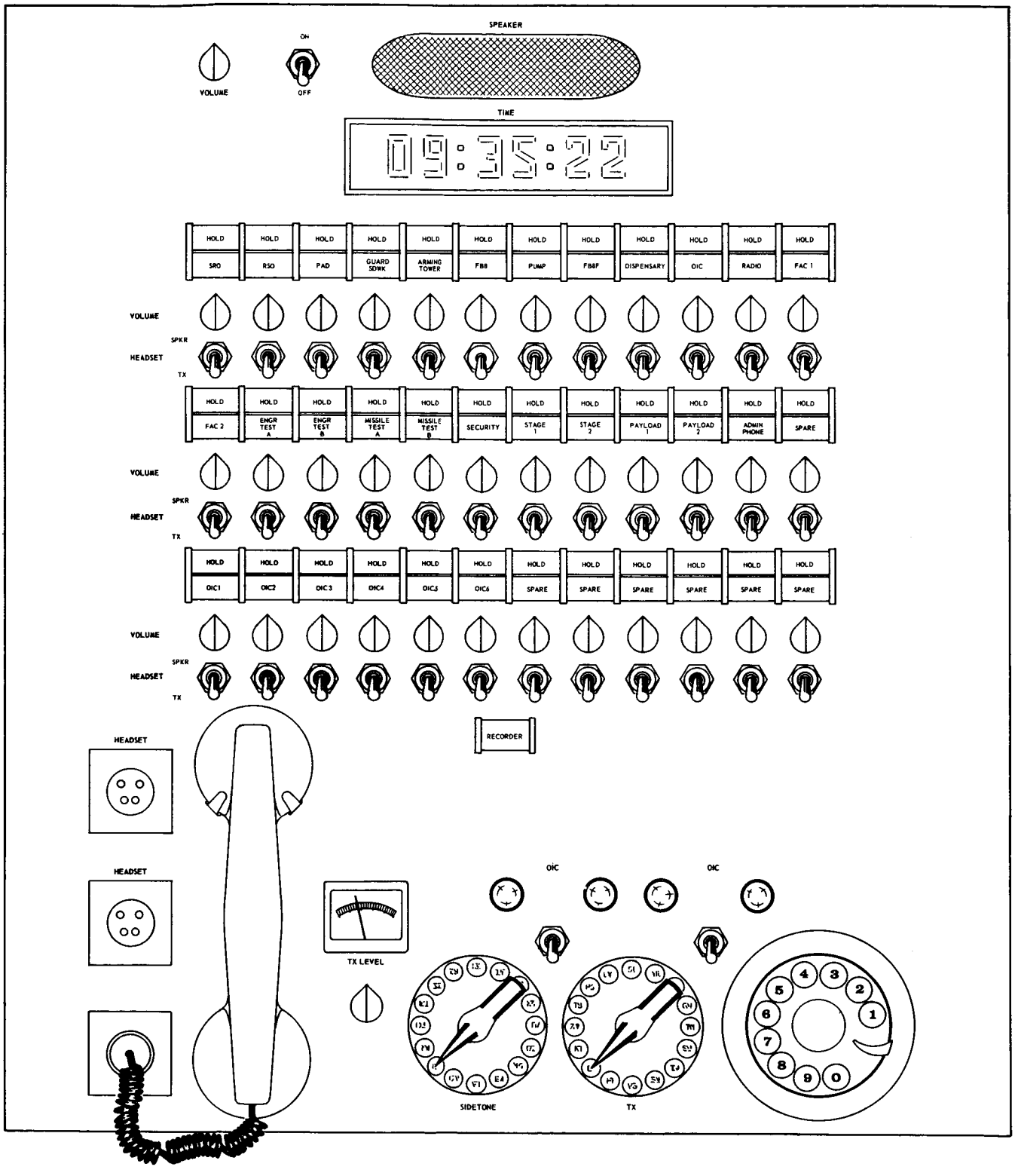

Figure 4. Communications Console

Operations Safety Officer (OSO) for decision-making and action on the information presented.

Specifically excluded at this time are detailed meteorological condition data (other than that presented via MIDS), the condition of the fuel dispersion systems, EBW firing voltage, missile fueling status, and ignition permission. Also, there is no direct capability for operating the paging system.

2.2 Status Panel

The upper left-hand corner of the status panel presents basic information on wind velocity and direction at the pad. This information can be of great utility to the OSO in generating evacuation instructions in the event of fire or leak of hypergolic propellants and also helps in assessment of danger to personnel working on the Launch Umbilical Tower and Arming Tower.

On the upper right-hand corner are a series of pad traffic control signal actuators. The OSC for either firing room controls the traffic signals for its pad. The buttons should be alternate-action switches that glow in the same color as the signals that they actuate. Switching logic is such that only one color can be illuminated at a time. The beacon pushbutton operates in an analogous manner. Just below the traffic control signals are activate/deactivate pushbuttons for the ensemble of blast gages and recorders located around the pad area.

Located beneath the foregoing controls and indicators are a series of status and/or condition indicators. The functions monitored by this bank are not subject to the direct control of the OSO, but knowledge of their status is essential to his functions. The groups labeled Apollo, LEM, and Stage

Status indicate condition of the Launch Escape System, Master Event Sequence Controller, first-stage ignition system, and the Command Destruct Receiver.

The group labeled Facility Status shows the condition of many critical elements of the ground support equipment. The labels on the individual indicators are self explanatory, and, taken together represent, in summary form, an adequate display of support equipment conditions affecting operational safety. In the event of an abnormal or hazardous condition, such as H_2 fire, the OSO is alerted to the fact. He may obtain additional information on the location, size, and criticality of the condition by telephone inquiry of the Master Hazards Monitoring Console in the Complex Control Center (CCC), or the operator of the Hydrogen Fire Monitoring Console, if the former console is not implemented as shown in reference 1, or he may "tune in" on a suitable channel of the Operational Intercom (OIC) to hear whatever discussion of the problem is in progress between individuals required to take action to investigate and control the fire and to protect the facility. Still another source of information to the OSO is the OTV on the center console, for it is reasonable to expect that, within a short interval, the operators of the IR/UV fire detection TV cameras will have trained their equipment on the source of the fire. Following assessment of the situation by the OSO, he can then take whatever measures are necessary to protect personnel and can, in consultation with the RSO, make recommendations to the SRO. It is worthy of note that, based on planning documents dated October 1964, all the conditions displayed in the Facility Status Group are actuated by alarm systems that are already provided by the equipment being monitored. That is, no modifications or additions to existing systems are needed to provide the status information that will be provided the OSO.

2.3 Communications Panel

As stated previously, the OSO will, in the course of his work, be in almost constant communication with various guard stations, tower locations, and facilities. Therefore, it is essential that he be provided with a highly flexible and extensive communications facility. The right-hand panel of the OSC provides this function in the following manner: all of the sites, organizations, etc., that are known to be in need of frequent communications with the OSO are provided with direct lines or "green phone" facilities to the OSC. These facilities are displayed and controlled by means of the three double rows of pushbuttons and associated volume controls and switches.

In order to communicate with any desired facility, the OSO plugs in either the telephone handset shown in figure 4 or a combination headset-microphone that is supported by his head and shoulders. The OSO then would depress, for example, the dispensary button. This would cause the green phone at the dispensary to ring while the dispensary button on the OSC would flash. When the telephone was answered, the button would glow continuously. If the OSO were to wish to place the call on "hold" while he conversed elsewhere, he would depress the adjacent dispensary hold button. The call would then be held and this condition indicated by transfer of glow from "Dispensary" to corresponding "Hold."

If the OSO wished to monitor (but not speak to) several of his green phone circuits, he could move the toggle switch corresponding to those circuits up one position, to "Headset," and then depress the desired buttons above these switches. Whenever any conversation was present on those circuits, the OSO would hear it, but would not interrupt it with his own speech.

During occasions when the OSO was away from his seat, or for some reason was not wearing earphones, he could transfer all channels up to a loudspeaker on the communications console. This transfer is effected when the toggle switch for any channel is in the upper position. The incoming conversation on that row and column is then passed through the speaker amplifier for which power and master volume controls are provided at the upper left of the console. The relative volume of each channel being fed to the speaker may be controlled by an associated potentiometer below the channel control pushbuttons.

The communications panel provides facilities not only for controlling "green phone" circuits, but also for using other circuits, such as the administrative phone, the OIC, and radio communications. These are selected in an identical manner to the former circuits. When the OIC is selected by pushbutton, the conventional rotary switches associated with the OIC are available to select the desired channels of the OIC, which are entered into the mixed audio lines.

Also provided are a VU meter and volume control for the speech amplifier feeding the radio link. During critical times and/or the occurence of critical events, a recorder may be connected to the mixed audio lines by depressing the "Recorder" pushbutton. Operation of the recorder is signaled by a continuous glow of the recorder pushbutton. Malfunctions, such as out of tape, etc., are signaled by intermittent flashing of this pushbutton.

2.4 Display Panel

The control panel of the OSC contains four television monitors. These monitors provide the OSO with information from the IR-UV fire detection TV system, weather briefings from the MIDS, and views of critical areas of the launch complex as provided by the OTV system.

Although the OSO has no direct control of TV camera position, he may request via his communications panel, that particular areas of the launch complex be covered. Depending upon the design of the TV distribution system, there is the possibility that video crossbar switches may be available at the distribution center. These switches would permit remote selection of several of the many camera chains used at LC-39 by the OSO from his console.

3. DATA TRANSMISSION SYSTEM

The control and display functions described above require, for the most part, the services of a digital data transmission system having a single bit per message. The only exceptions arise in the indicators of pad wind direction and velocity, which require very low bandwidth analog data; the TV monitors, which require video bandwidth analog data; and the interphone system, which requires voice bandwidth analog data plus signaling data indicating both ringing and connection. The latter system is highly specialized and falls within a technical area having considerable background.

The data transmission system needed to operate the on-off indicators can assume many forms, the best form being that which provides the needed service at a minimum of cost, for technical constraints are minimal. It appears likely that if many of the signals appearing on the OSC are used also at other consoles, decoding functions should be performed in the Master Hazards display area in the CCC, and the signals passed to all firing room displays via hard wire.

The general scheme for transmitting instrumentation data from the pad to the LCC has been prepared by the Engineering Support Division and is shown in a set of drawings identified as ES329H-0105, dated 25 January 1965. These drawings show a general scheme for both the wideband TV distribution system and for the narrow bandwidth detectors such as would be used for warning of gas leaks.

4. SUMMARY

The results of the study and review of the Hazards Monitoring Data Display and Transmission System Requirements can be summarized as follows:

(a) Portions of the display system presented in Volume II, Report on NASA Contract No. NAS 10-1420, September 1964, still represent a valid and efficient means of indicating the status of potential hazards.

(b) Detailed meteorological condition data (other than that presented via MIDS), the condition of the fuel dispersion system, EBW firing voltage, and ignition permission can be excluded from the OSC.

(c) No modifications or additions to existing systems are needed to provide signals for the status information that will be provided the OSO.

(d) It is essential that the OSO be provided with a highly flexible and extensive communications facility.

(e) Four television monitors are required to provide the OSO with information from fire detection systems, weather briefings, and critical areas of the launch complex.